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# The effect of certain biotic factors on the demographic parameters of *Scheloribates cf. latipes* (Acari: Oribatida)

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With 5 figures

**Synopsis:** *Original scientific paper*

Diet strongly affects the demographic parameters of adult *S. cf. latipes*. Grazing on a mixture consisting of litter detritus in later decomposition stages and the lichen *X. parietina*, *S. cf. latipes* displayed the highest fecundity, the lowest mortality and the lowest coefficients of variation. Moss is an essential component of *S. cf. latipes* habitat facilitating egg deposition and the preecdysial immobilisation of immatures. Contamination of cultures by fungal hyphae and faeces affected the demographic parameters of adult *S. cf. latipes* due to their toxicity. An acarine (Bdellidae) predator attacked only moving immatures of *S. cf. latipes*, while the preecdysial immobilisation phase was considered as a refuge against predation. A "Type-A" or "Type-B" functional response of the predator was recorded and was related to the time the predator needs to become hungry after prey consumption. The highest rate of predation was displayed by fasting predators on the first day, and the lowest by satiated predators on the third day, of a four day experiment. The ways in which *S. cf. latipes* can overcome constraints of the biotic components of its environment are discussed.
**Key words:** Acari, Oribatida, *Scheloribates cf. latipes*, culturing diet, fungi hyphae, predation, demographic parameters.

## 1. Introduction

In two previous papers (Asikidis & Stamou, 1991, 1992), we studied the spatial and temporal distribution patterns of oribatids of a *Quercus coccifera* (L.) formation on Mt Hortiatis and *Scheloribates cf. latipes* (C. L. Koch) was one of the numerically most important species. In the present paper we provide some information gathered in the laboratory during 1986 on the effect of certain biotic factors on the demographic parameters of this species. Further information concerning the effect of certain abiotic factors on the demographic parameters and the activity of *S. cf. latipes* will be given later.

## 2. Materials and methods

Newly emerged adult and immature *S. cf. latipes* were cultured in the laboratory by using cylindrical plastic containers 2.5 cm in diameter, with a 9 : 1 mixture of plaster of Paris and charcoal as substrate. Details on the culturing method have been given elsewhere (Stamou, 1989).

To assess the effect of diet on adult demographic parameters, particularly on fecundity, the following foods were offered: Fresh and dried litter, decomposed litter and humus of *Q. coccifera*, fresh and dried moss, as well as the lichens *Xanthoria parietina* (L.) Th. Fr., *Cladonia foliacea* (Huds.) Schaer, and *Physcia adscendens* (Bitt.) collected from the field. The cultures (five replicates) were investigated daily and the number of deposited eggs and dead specimens was recorded. The latter were removed and replaced by live ones from stock cultures. The experiment lasted for 70 weeks at a constant temperature of 25 °C. To avoid contamination of cultures by fungal hyphae, faeces were removed and foods were renewed every three days. The effect of culture contamination by hyphae and remaining

faeces on adult demographic parameters was monitored in additional cultures (again five replicates). In these cultures faeces and foods remained inside for 15 days.

To estimate the predation rate of a prostigmatid mite (Acari: Bdellidae), predators were kept fasting for 60 h. Then, they were introduced singly in cultures containing 5, 10 or 15 specimens of *S. cf. latipes* all of the same life stage (five replicate cultures per prey density). The cultures were kept at 25 °C and the predation rate was recorded daily for four days.

## 3. Results

In tab. 1 results regarding the effect of diet on the fecundity and the mortality of adult *S. cf. latipes* are shown. Fresh, and dried litter in early stage of decomposition, moss and the lichen *C. foliacea* were not sufficient foods for life cycle development. Almost all animals died within a 30 day period. In only two cultures with dried litter detritus and *C. foliacea* four and six eggs were laid respectively a few days after the introduction of the animals into the culturing vessels (possibly from already fertile females).

Table 1. The effect of diet on the demographic parameters of adult *S. cf. latipes*.

| Diet | N | T | $f_x$ | CV% | $m_x$ | CV% |
|---|---|---|---|---|---|---|
| *X. parietina* | 45 | 50 | 0.056 ± 0.010 | 38 | 0.74 ± 0.10 | 25 |
| *P. adscendens* | 25 | 50 | 0.057 ± 0.020 | 66 | 0.66 ± 0.30 | 54 |
| *C. foliacea* | 30 | 50 | 0.003 ± 0.001 | 22 | 1.58 ± 0.10 | 19 |
| Moss | 33 | 30 | — | | 3.30 | — |
| Fresh litter | 13 | 30 | — | | 3.10 ± 0.20 | 10 |
| Dried litter | 29 | 50 | 0.004 ± 0.004 | 73 | 1.68 ± 0.06 | 7 |
| Decomposed litter | 65 | 50 | 0.044 ± 0.020 | 78 | 1.28 ± 0.20 | 31 |
| Faeces of *G. balcanica* | 24 | 30 | — | | 2.90 ± 0.30 | 13 |
| *X. parietina* + Decomposed litter + Moss | 50 | 50 | 0.088 ± 0.010 | 13 | 0.40 ± 0.04 | 16 |

Note: N: number of specimens on which estimations have been based, T: duration of observations (in days), $f_x$: fecundity (eggs/female/day), $m_x$: mortality (% dead specimens/day) and CV%: coefficient of variation.

The report of CLEAT (1952) that *S. laevigatus* was a coprophage encouraged us to offer to *S. cf. latipes* faeces of *Glomeris balcanica* (VERHOEFF). This Diplopod is numerically dominant among macrofauna species inhabiting the litter layers of *Q. coccifera* at Hortiatis (IATROU, 1989). The experiment showed that this material, and the microflora developed on it, were unpalatable to *S. cf. latipes*.

Adult *S. cf. latipes* grazing on litter in later stages of decomposition displayed high fecundity and low mortality rates. Nevertheless, the coefficients of variation, usually used as an index of the optimality of culturing conditions, were also high.

Diet consisting either of *X. parietina* or *P. adscendens* allowed for the development of the life cycle of *S. cf. latipes* in the laboratory. High rates of fecundity and low mortality rates were recorded. Relatively high values of the coefficients of variation were estimated only in cultures with *P. adscendens*.

The highest rate of fecundity, the lowest mortality rate and the lowest values for the coefficient of variation were recorded in cultures with *X. parietina*, litter in later stages of decomposition, and moss. It should be noted that adults did not consume moss, but that the majority of eggs were laid on it. ASIKIDIS (1989) reported that for most juveniles preecdysial immobilisation also took place on moss.

A highly significant decrease of adults mean survivorship occurred in cultures where food and wastes were removed every 15 days (t-test; tab. 2). The maximum life span of adults was about 50 weeks and 50% of them died within 27 weeks (fig. 1). On these data

Table 2. The effect of fungal hyphae development and deposited faeces on the demographic parameters of adult *S. cf. latipes*.

| Demographic parameters | Uncontaminated cultures | Contaminated cultures |
|---|---|---|
| Mean life span (weeks) | 38 ± 4.6 | 27 ± 3.2 |
| Time when 50% die (weeks) | 40 ± 3.8 | 27 ± 2.6 |
| Mean Fecundity (eggs/female/day) | 0.100 ± 0.01 | 0.038 ± 0.01 |
| Duration of reproduction period (weeks) | 50 ± 3.4 | 36 ± 5.1 |

was fitted the logistic equation $S = 100/\{1 + \exp(-6.81 + 0.24t)\}$, where S = survivorship and t = time. Further analysis of covariance showed that both coefficients of this equation are significantly different from those of a similar equation fitted by ASIKIDIS (1989) to data from uncontaminated cultures ($P < 0.01$).

Contamination of cultures also resulted in decreasing fecundity rate and reproduction period (fig. 2). The data were substituted in the periodic equation $F = \exp\{0.024 + 0.025 \times \cos[(2\pi(t - 19)/48]\}$ (where F = fecundity and t = time; STAMOU, 1986). The time period of 48 weeks is less than the oviposition period in uncontaminated cultures estimated to last for 54 weeks (ASIKIDIS, 1989). Analysis of covariance showed that the constants 0.024 and 0.025, defining the acuteness of the curve, are significantly lower than those estimated for a similar equation fitted by ASIKIDIS (1989) to data from uncontaminated cultures ($P < 0.01$). Maximum egg deposition rate was recorded in the 13th week and was 0.210 eggs · female$^{-1}$ · day$^{-1}$. This value is significantly less than that recorded in uncontaminated cultures in the 15th week by ASIKIDIS (1989).

LEBRUN (1968) suggested that the addition of Oppiidae species in cultures of oribatids prevent the harmful effect of hyphae development. The results obtained during this experiment from cultures with Oppiidae species did not verify this suggestion.

To estimate the live mass of adult and immature specimens of *S. cf. latipes*, the equation $\log W = 2.09 \log L + 0.93 \log l - 6.67$ (where W = live mass, L = length and l = width) was used (LEBRUN, 1971). In tab. 3 results regarding the rate of predation on juveniles of *S. cf. latipes* are given. Analysis of variance showed that consumption rate depends

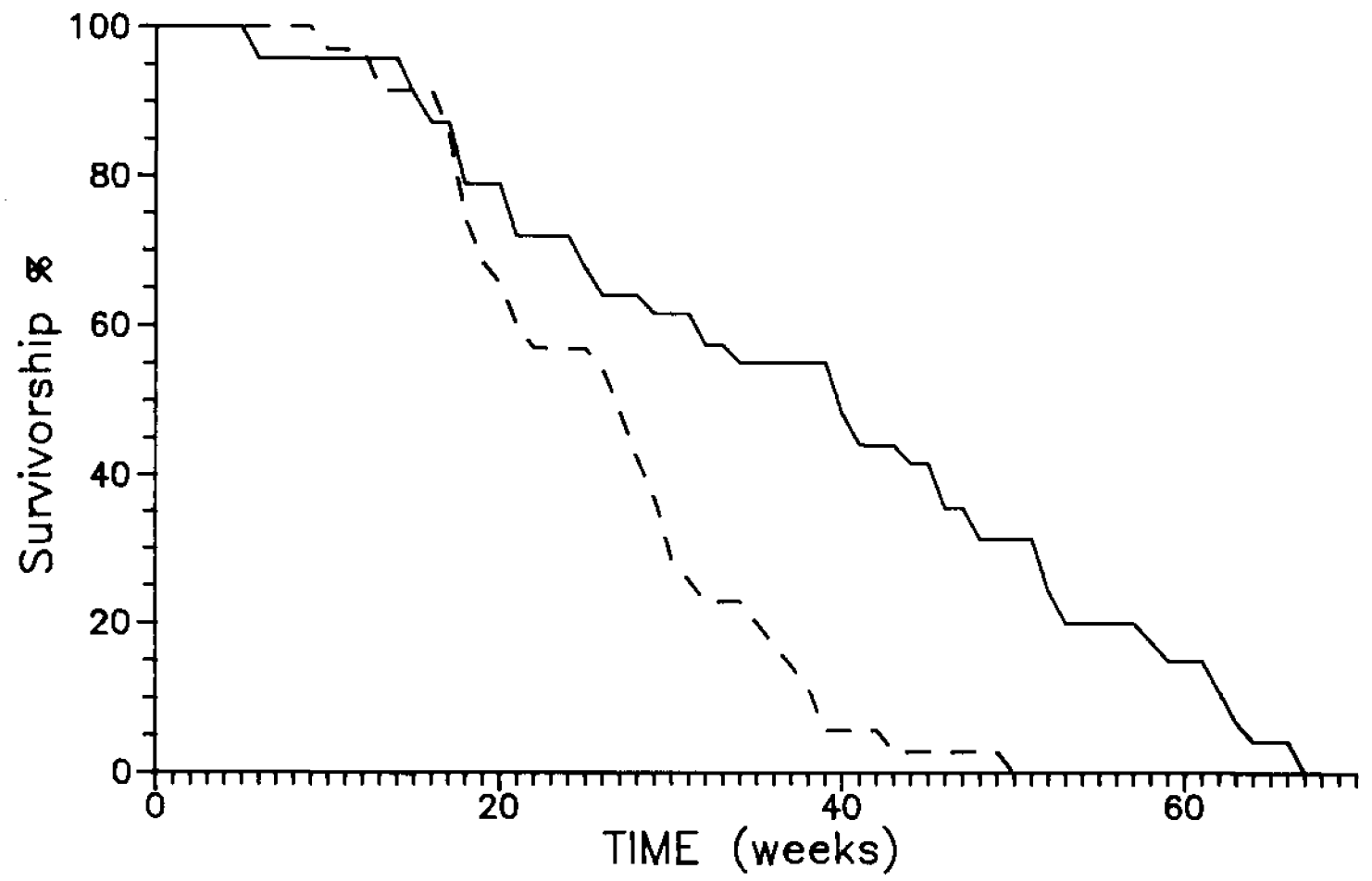


Fig. 1. The effect of culture contamination by fungal hyphae and deposited faeces on the survivorship of the adults *S. cf. latipes*. Dashed line: contaminated cultures. Solid line: uncontaminated cultures. (Data concerning uncontaminated cultures from ASIKIDIS, 1989).

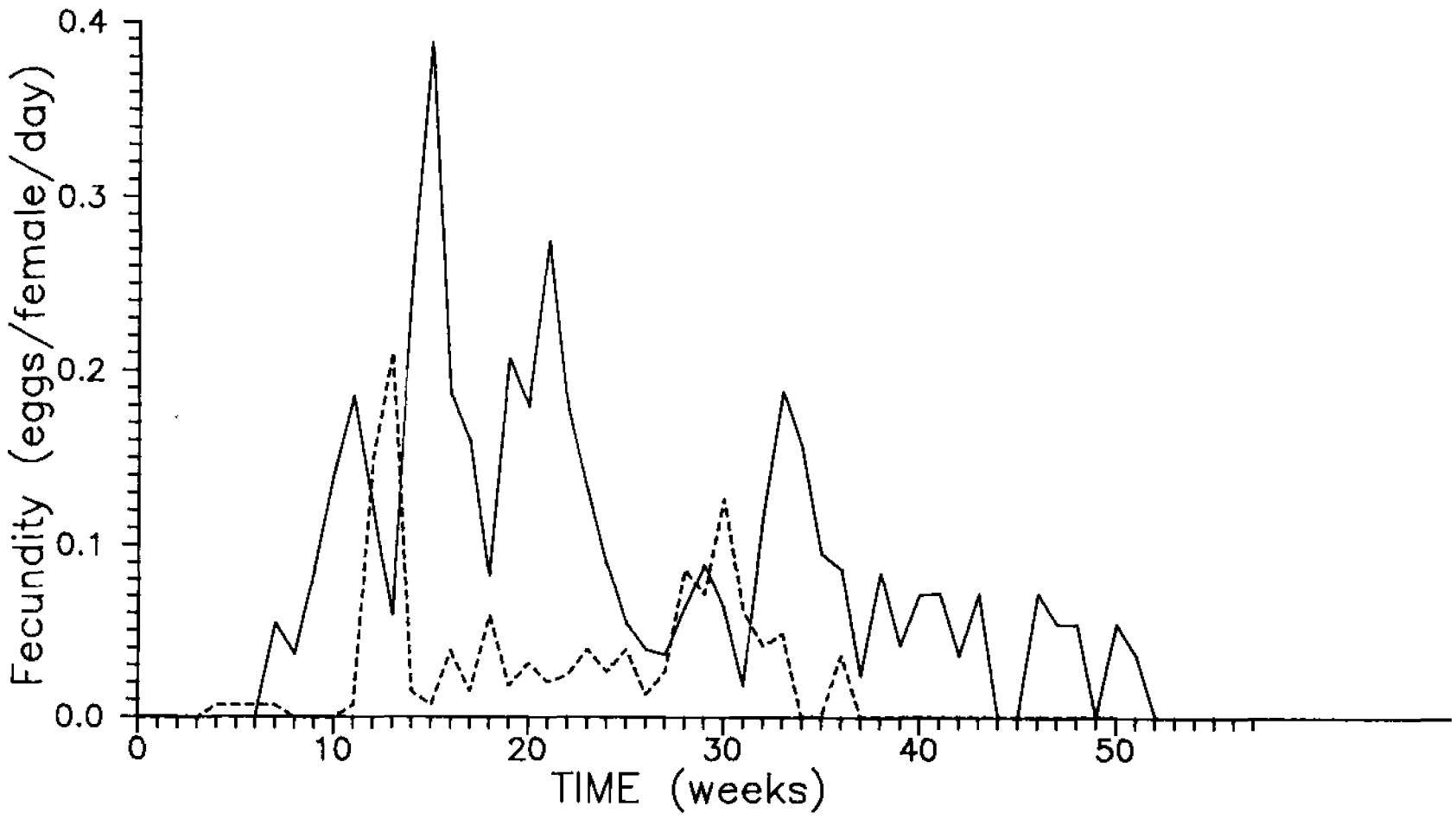


Fig. 2. The effect of culture contamination by fungal hyphae development and deposited faeces on the fecundity of *S. cf. latipes*. Dashed line: contaminated cultures. Solid line: uncontaminated cultures. (Data concerning uncontaminated cultures from ASIKIDIS 1989).

significantly on the day of the experiment, the density of prey, as well as on the life stage of the animals. It is worth noting that consumption of adults, as well as of immatures in preecdysial immobilisation, was not recorded. On the contrary, in cases where supplementary predators were introduced to the cultures cannibalism resulted, similar to that reported by BATTACHARYYA (1962) and STAMOU (1989).

On the first day of the experiment, starving predators fed voraciously on prey (fig. 3), while by the third day the almost satiated specimens displayed the lowest consumption rate.

In fig. 4 the functional response of the predator is depicted. It falls in the "Type-A" or the "Type-B" category of HOLLING (1959) with a saturation prey density of about 15 individuals per culturing vessel.

The searching efficiency of predators increases with the life stage of prey (fig. 5). It seems likely that earlier life stages escape predation by taking refuge in the substrate holes,

Table 3. Predation (in mg of prey/predator/day) on the immatures *S. cf. latipes*.

| Life stage | Prey number density | Day of experiment | | | | Means |
|---|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th | |
| Larvae | 5 | 5.06 | 4.40 | 2.20 | – | 3.89 |
| | 10 | 7.26 | 5.94 | 2.20 | 2.86 | 4.57 |
| | 15 | 9.46 | 6.60 | 5.09 | – | 7.04 |
| Protonymphs | 5 | 9.18 | 3.40 | 3.40 | – | 5.32 |
| | 10 | 17.00 | 7.82 | 4.42 | 4.42 | 8.12 |
| | 15 | 17.00 | 10.20 | 4.42 | 4.42 | 9.06 |
| Deutonymphs | 5 | 11.75 | 8.69 | – | – | 10.22 |
| | 10 | 20.44 | 6.64 | 3.58 | 6.64 | 9.33 |
| | 15 | 20.44 | 10.22 | 5.11 | 8.69 | 11.12 |
| Tritonymphs | 5 | 17.04 | 8.52 | 5.96 | 8.52 | 10.01 |
| | 10 | 23.00 | 14.48 | 8.52 | 11.08 | 14.27 |
| | 15 | 23.00 | 14.48 | 8.52 | 14.48 | 15.12 |
| Means | | 15.05 | 8.45 | 4.87 | 7.64 | 9.22 |

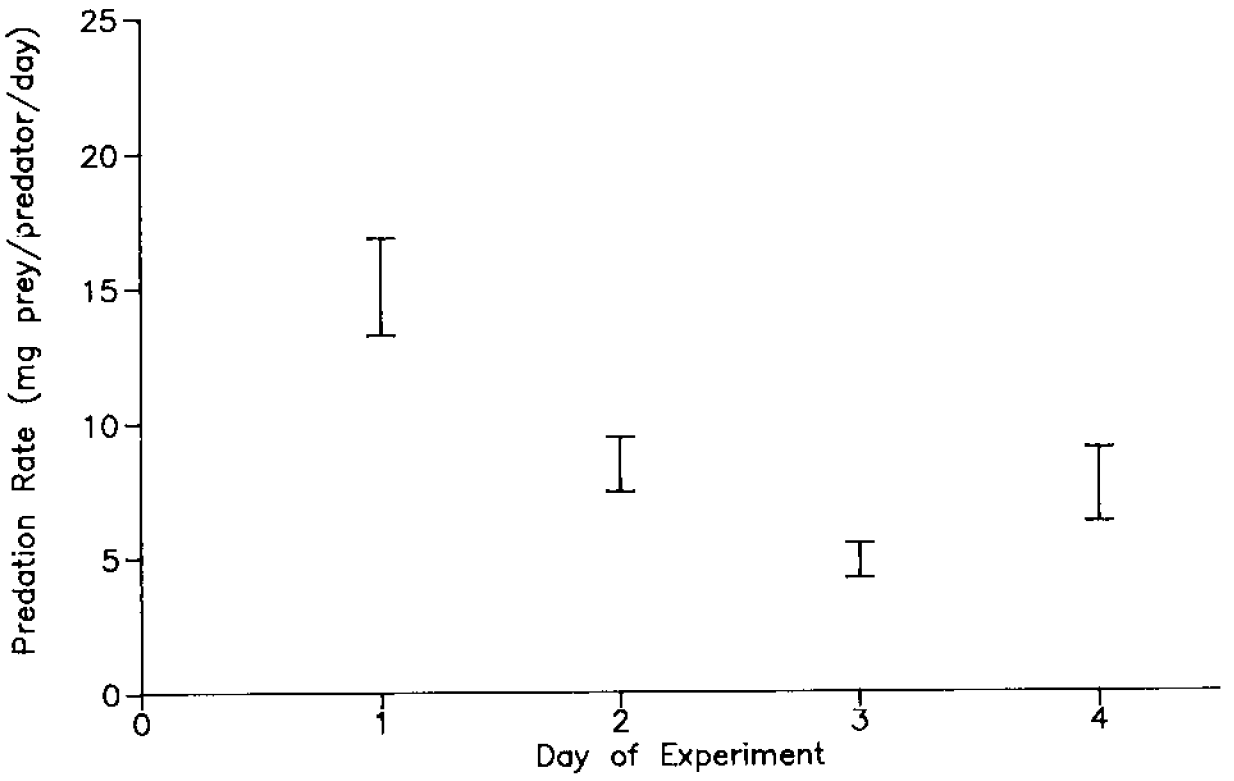


Fig. 3. Predation rate (mg of prey/predator/day) in relation to the date of a four day experiment.

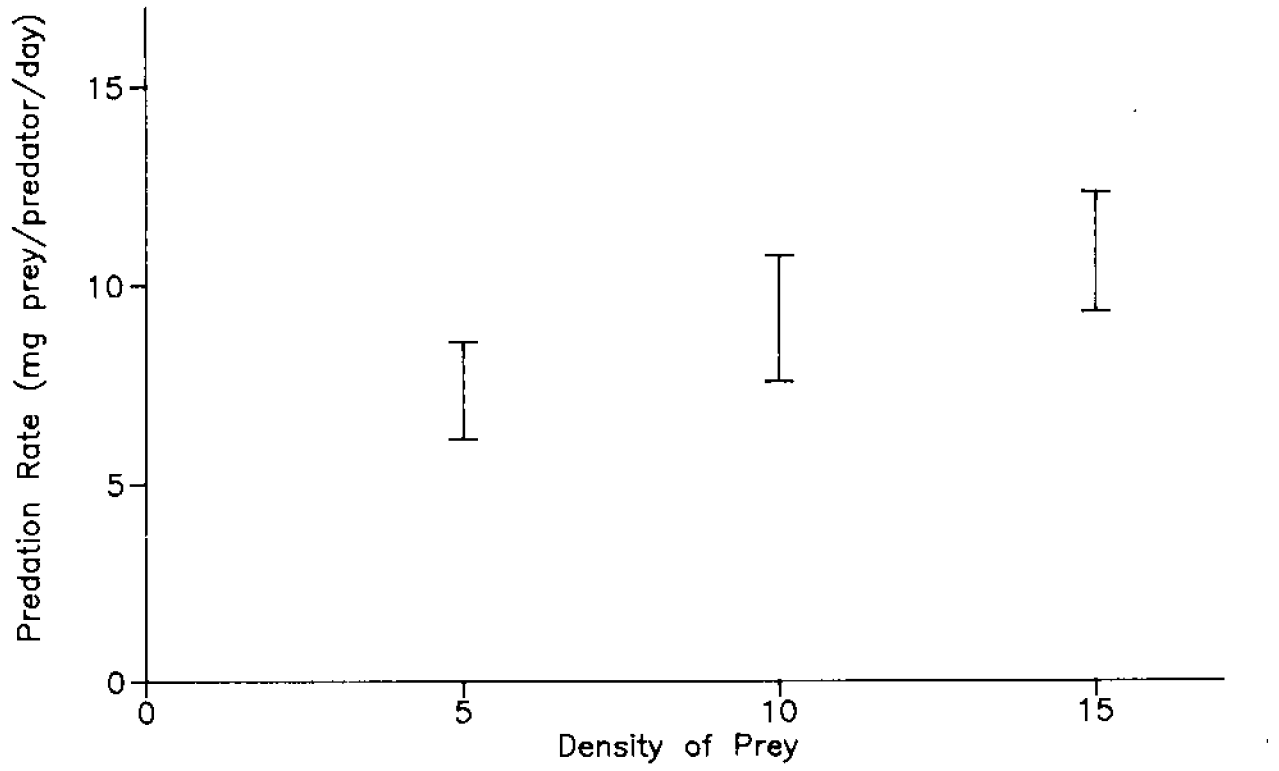


Fig. 4. Predation rate (mg of prey/predator/day) in relation to prey density. Predators' functional response is comparable to "Type-A" or "Type-B" of HOLLING (1959).

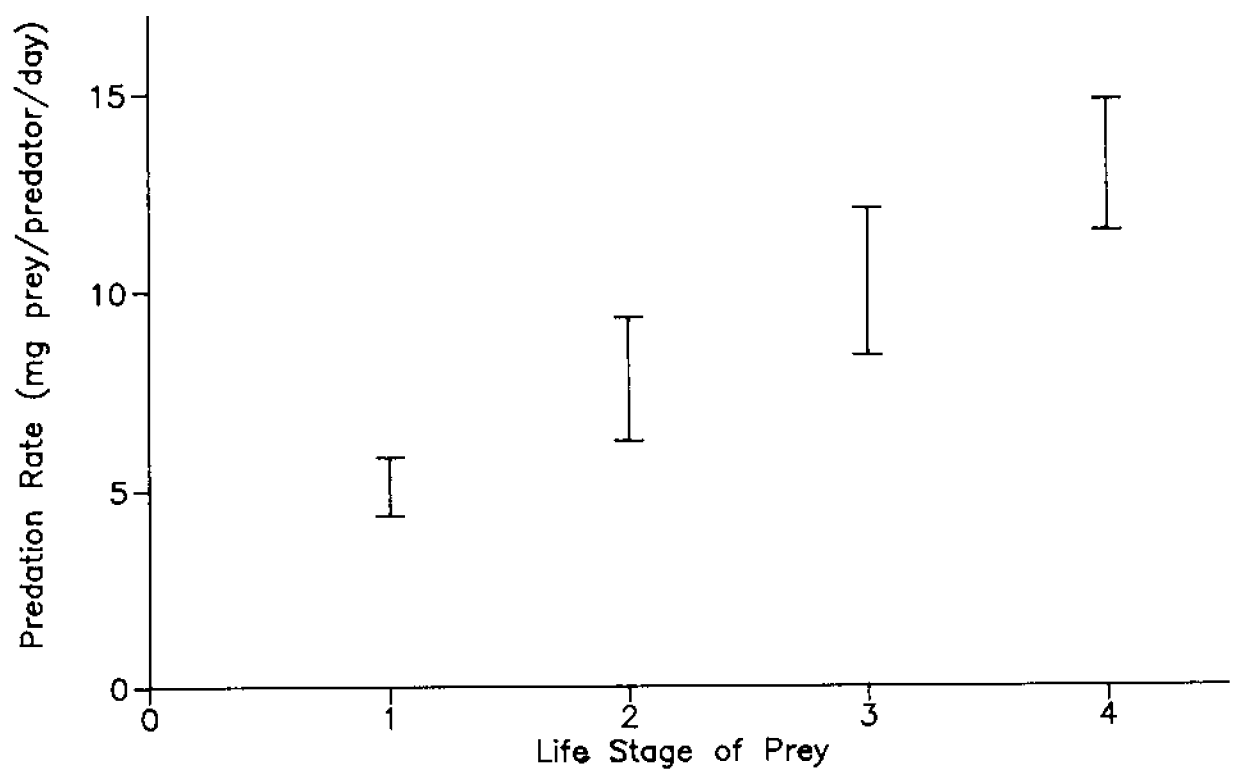


Fig. 5. Predation rate (mg of prey/predator/day) in relation to the life stage of prey.

the availability of which decreases as the body size increases. In any case it must be mentioned that the real consumption of predators should be less than that recorded, due to the fact that predators consumed only soft body parts avoiding the exoskeleton. So, greater estimations of the real consumption are more likely in earlier life stages.

## 4. Discussion

Fresh materials (litter and moss) were unpalatable to *S. cf. latipes*. Similar conclusions have also been reported for other oribatid species (e.g. HARTENSTEIN, 1962b). WOODRING (1963) reported that *Scheloribates laevigatus* (C. L. KOCH) consumed green herbs but its life cycle did not develop. Indeed, *Scheloribates* has been classified as a microphytophage species consuming microorganisms (LEBRUN, 1971; LUXTON, 1972; KANEKO, 1988).

The food supplies favouring the development of the life cycle of *S. cf. latipes* in the laboratory consisted of microflora developed on litter detritus in a later stage of decomposition, the lichen *X. parietina*, and moss. The latter being unpalatable to the animals, should be considered as an essential component of their habitat facilitating egg deposition and preecdysial immobilisation of juveniles.

The nutritional preferences of *S. cf. latipes* are comparable to those of other species sampled at Hortiatis, namely *Pilogalumna allifera* (DUDEMANS) and *Achipteria oudemansi* (VAN DER HAMMEN). Also *Carabodes minusculus* (BERLESE) and *Steganacarus pulcherrimus* (BERLESE) fed on *C. foliacea* and *Hermanniella granulata* on decomposing litter and diverse lichens (ASIKIDIS, 1989). It seems that at Hortiatis lichens are an essential component of the diet of oribatids.

SAICHUE *et al.* (1972) suggested that for the reproduction of *Nothrus biciliatus* (C. L. KOCH) the qualitative composition of food supply was of greater importance than its rate of consumption. The significance of the food quality was also stressed by STAMOU *et al.* (1981) for *Achipteria holomonensis* (CANCELA et STAMOU), while MITCHELL & PARKINSON (1976) and CANCELA DA FONSEĆA & POINSOT-BALAGUER (1983) stated that it holds for the majority of oribatids. The results of this experiment add support to this suggestion and furthermore underline the importance of habitat infrastructure for life cycle development.

The development of hyphae in cultures, in experiments comparable to that reported here, is always determined to oribatids (LEBRUN, 1974; CANCELA DA FONSECA, 1975). STAMOU (1989) reported that hyphae development affected the demographic parameters of only adult *Achipteria holomonensis*. GRANDJEAN (1948) stated that the harmful effect of hyphae is due either to the immobilisation of specimens among them or to their toxicity. STAMOU & ASIKIDIS (1989), studying density dependence phenomena, suggested that not only hyphae development but also faeces toxicity should have a combined long-term effect on the demographic parameters of adult oribatids by contaminating food and substrate. Indeed, in cultures where faeces and foods were removed every 15 days, not only mortality rate, but also life span, egg deposition rate and the reproduction period were affected.

Bdellidae species are considered important predators of oribatids (WALLWORK, 1967). In this experiment predation was recorded only on immature *S. cf. latipes*. ASIKIDIS (1989) reported predation of the same predator on immature *P. allifera*, the characteristics of which were identical to that reported herewith for *S. cf. latipes*, while he recorded an extremely low rate of predation only on larvae of *A. oudemansi*. No adult consumption was recorded for any of the above species which, following LEBRUN (1970) and STAMOU (1989), can be attributed to the hardness of their exoskeleton. Also HARTENSTEIN (1962a) reported that *Pergamasus crassipes* (L.) and *Amblygamasus septentrionalis* (OUDEMANS) were attacted mainly to immature oribatids and collemboles.

The results of this study showed that the predator cannot attack specimens in preecdysial immobilisation. Immobilization of the immature *S. cf. latipes* lasted for the 1/3 of each life stage duration (ASIKIDIS, 1989). Thus, preecdysial immobilisation, a part of an oribatid's life cycle, can be considered as a refuge against predation.

Densities of 5, 10 or 15 immatures per culturing vessel correspond to field population densities of 15000–45000 individuals $m^{-2}$. The maximum field density recorded for immatures was 3300 individuals $m^{-2}$. Besides, taking into consideration the possibility of specimens horizontal and vertical dispersion we conclude that the rate of predation in the field should be much lower than that recorded in the laboratory.

The mean predation rate recorded for *A. cf. latipes* was less than that recorded for *P.allifera* (9.23 vis. 11.68 mg prey · predator$^{-1}$ · day$^{-1}$; ASIKIDIS, 1989). This can be attributed to the fact that immatures of *P. allifera* were apparently less mobile than those of *S. cf. latipes*. Moreover, the specimens of the former species formed rather permanent aggregates on food items, which resulted in an increasing searching efficiency by the predator. In any case, both these predator consumption rates are greater than those reported by LEBRUN (1970) for the system *Pergamasus sp. — Nothrus palustris* (C. L. KOCH).

The functional response of the predator was of "Type-A" or "Type-B". In general, these response types were related to the time available to the predator for prey seeking (ARDITI, 1979). For the predator-prey system studied during this experiment it should be attributed rather to the time the predator needed to become hungry again after prey consumption. Indeed, although it remained active immediately after prey consumption, it did not undertake new attacks. This suggestion is in agreement with the observation that the balance between fasting and satiation controls predator activity in time.

The biotic components of the environment strongly affect the demographic parameters of adult *S. cf. latipes*. The results of this study show that the development of the life cycle of this species is highly dependent on food composition and quality, as well as on microhabitat infrastructure. Furthermore, it is heavily exploited by predators. *S. cf. latipes* is capable of encountering these constraints on its biotic environment, exhibiting a high rate of displacement triggered by individuals touching (STAMOU & ASIKIDIS, 1989). It enables *S. cf. latipes* to increase food searching efficiency, protects resources from overexploitation and contamination and prevents the formation of aggregates on food, thereby diminishing the searching efficiency of predators. The formation of small aggregates on food, in combination with the fact that the dependence of *S. cf. latipes* demographic parameters on number density is of "Alle-type" (STAMOU & ASIKIDIS, 1989), partly results in elevated population size in a biotope characterized by adverse climatic conditions (ASIKIDIS, 1989).

## 5. Acknowledgements

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